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ABSTRACT

This project investigated the effects of increasing teachers' wait times on general questioning skills in science teaching. Variables were separated through the use of four treatment groups, each containing ten science teachers. Schools were randomly assigned to four treatment conditions from a subsampling of middle schools in a central New York state county. One group received instruction in wait time using a newly developed electronic feedback device that monitors the duration of teacher and student pauses; a second received general questioning skills instruction; a third received both types of instruction; and a comparison group received no instruction of either type. Use of written materials on questioning produced only a slight increase in teacher wait times, but feedback devices caused significant increases. Interaction effects were found significant favoring those who had access to the devices without the additional complication of reading the written materials. Treatment effects were maximized at the project's fifth week, and diminished as the school year's end approached. The greatest behavior change noted in analysis was the increase in the amount of total classroom discussion time with active student participation. (MP)

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Modifying Teacher Questioning Behavior In Classroom Interaction

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Abstract

Investigations of teacher-student interaction have indicated that teachers pause only briefly after posing questions to students. Teachers typically wait less than one second for a student response. This project investigated the effects of increasing teachers' wait times on general questioning skills in science teaching. In previous research, the influence of wait time training has been confounded with instruction in general questioning skills, making it difficult to test the hypothesis that increasing the wait time will by itself improve classroom discussions. In this project, these variables were separated through the use of four treatment groups, each consisting of 10 science teachers. One group received instruction in wait time using a newly developed electronic feedback device that monitors the duration of teacher and student pauses; a second group received instruction in general questioning skills; a third group received both types of instruction; a comparison group received no instruction of either type. Audio tape recordings of classroom interaction were analyzed in terms of teacher questioning behavior (including wait time as well as other variables) and student responses. Use of written materials or questioning produced only a slight increase in the teacher's wait times. The use of the feedback devices caused the teachers to increase their wait times significantly. Interaction effects were also significant, favoring those who had access to the devices without the additional complication of reading the written materials. Treatment effects were maximized at the fifth week of the project, then diminished as the end of the school year approached. The greatest change in behavior that was noted in the analysis was the increase in the amount of total classroom discussion time with active student participation.

Modifying Teacher Questioning Behavior In Classroom Interaction

Investigations pioneered by Rowe (1974a, 1974b, 1978) identified two pauses in the dialog between elementary school teachers and their students that appear to be critical variables in the determination of the cognitive level and the affective climate of classrooms. The first pause occurs after teachers ask questions (and before students respond). The second occurs after students pause momentarily in their replies without teachers ascertaining that the students have completed their replies. Rowe has labeled the pauses wait time 1 and wait time 2 respectively. She found the first to be about 0.9 seconds long, the second to be about one second. She also found that significant improvement in the intellectual and interpersonal climate of the science classrooms could be produced by training teachers to increase the length of these pauses to three seconds or longer. Others (Chewprecha, 1977; DeTure, 1979; Hassler & Fagan, 1980; Marsh, 1978; Tobin, 1979; Winterton, 1976) have extended these findings to high school and college classes in many subject-matter disciplines.

Objectives

Efforts to train teachers to increase their pauses following questions have been only partially successful. Difficulties in training teachers to use wait time of three seconds prompted the development of an electronic device that provides immediate feedback concerning the duration of wait time pauses (Swift & Hawkins, 1979). This monitor permitted feedback to be given to teachers and students free of other information regarding

teaching skills. In previous research, the influence of wait time training has been confounded with instruction in general questioning skills, making it difficult to test the hypothesis that increasing wait time by itself would improve questioning skills. This study allowed the examination of these variables in isolation and together.

The main effects examined in the study were: 1. the use of printed materials (discussion guides on effective questioning strategies) and 2. the use of the wait time feedback devices. A factorial design was utilized, as illustrated in Figure 1, thus permitting the examination of interaction effects.

Insert Figure 1 about here

Method

Independent Variables

1. Training. Use of printed materials on questioning techniques in classroom discussion.

2. Feedback. Use of the wait time devices to provide immediate feedback on pauses following questions and responses.

In the training conditions teachers were provided with a series of eight instructional booklets called Discussion Guides. Each guide described a principle of effective questioning, such as the importance of pausing following questions or the significance of asking questions at higher cognitive levels. The booklets also provided examples of the principles and gave suggestions for their use in class.

In the feedback conditions teachers used the electronic apparatus during their class discussions, which gave them an immediate monitoring of

their wait times. Through the operation of a voice activated relay system, the teacher was provided with a green light signal when the appropriate criterion of a three second pause was met. A red light indicator on the classroom apparatus showed that someone was talking or that the three second pause criterion had not yet been met.

Description of the Four Groups

The participants assigned to group I served as a comparison group with class discussions being taped for analysis. The teachers assigned to experimental group II were provided with instruction in effective questioning techniques. Recording devices were installed in their classes for monitoring discussions, but wait time feedback devices were not used. Experimental group III consisted of teachers whose classrooms had wait time feedback monitoring devices provided for their use. These teachers were not given instructional protocols on effective questioning techniques, but were instructed only in the use and purpose of the feedback devices. Group IV was given wait time feedback monitors and each teacher received printed instructional protocols describing effective questioning techniques.

Hypotheses

It was hypothesized that the experimental groups of teachers would exhibit: (A) a more conversational tone in their classrooms as shown by 1) longer wait time durations, 2) decreased questioning rates, 3) greater length of responses, 4) more frequent questions from students, and 5) less teacher domination; (B) improved affective climate as shown by 1) fewer failures to respond, 2) decreased numbers of disciplinary acts, 3) fewer inflected responses, 4) fewer interruptions of each other, and 5) fewer derogatory comments; and (C) improved cognitive levels as shown by 1)

greater uses of high level questions by teachers, 2) fewer memory level questions, and 3) more student responses that contain statements of evidence or suggested experiments.

Dependent Variables

Variables reflecting teacher behavior which were analyzed in this study include 1) frequency of questions, 2) classification of questions, and 3) frequency of disciplinary remarks. Measures of student behavior include 1) length of responses, 2) frequency of student generated questions, 3) failure to respond, and 4) inflected responses. Those reflecting both teacher and student behavior include 1) length of wait time, 2) frequency of interruptions, and 3) the classroom interaction pattern.

Subjects

A sample of 40 middle school science teachers was drawn from among experienced faculty members in 5 suburban school districts. The sample of schools was obtained by subsampling the middle schools in a central New York state county. The teachers in the study were assigned to four groups of ten teachers with each group consisting of one to seven teachers from three or more schools as illustrated in Figure 1. The sample of teachers was drawn randomly from middle school teachers within schools. The schools were randomly assigned to the four treatment conditions. Clusters were necessary to minimize the transfer of ideas or apparatus from one experimental group to another. One class from the total number of sections of science instruction offered by each teacher participant was utilized in this project.

Procedure

As a condition of volunteering to participate in the study, each teacher was asked to conduct one discussion period per week which was

tape recorded. After an initial period of three weeks to accustom the teachers and students to preparing tape recordings and for the gathering of base-line data, the experimental variables were introduced. Those using feedback devices were instructed in proper usage of the instruments. Those receiving the printed instructional materials received one Discussion Guide each week for eight weeks. The comparison teachers received encouragement through placebos on three occasions. Tape recordings continued to be collected for an additional four weeks to evaluate the stability of the treatment.

An impartial observer coded the tape recordings so that the name of the teacher, treatment number, and date of the tape were not revealed to the analysis team. After transcriptions of the tape recordings, data gathered from teacher participants was recorded on logging sheets. Wait times were measured using special computer driven equipment designed to monitor pauses in human speech (Gooding, S. T., Gooding, C. T., & Swift, J. N., 1982). Pre-data, intermediate-data, and post-data was tabulated for all 40 participants.

Results

Analysis of variance revealed that there was significant interaction between the guide and the feedback treatment groups, with respect to wait time. Table 1 shows the summary of the ANOVA for wait time 1 and 2. Printed materials produced only a slight increase in the teacher's wait times. The use of the feedback devices caused the teachers to increase their wait times significantly. Interaction effects were also significant, favoring those who had access to the devices without the additional complication of reading the written materials.

Insert Table I about here

A canonical discriminant function analysis was also performed which denoted that treatment effects were maximized by the time of the fifth week of the project. Subsequently, the differences among the treatment groups were diminished as the semester evolved toward termination of the school year.

The graph in Figure 2 indicates that the four groups, while similar to begin with, soon developed distinctly different pause patterns in classroom interactions. This is illustrative of the power of the wait time feedback procedure in changing behavior of teachers.

Insert Figure 2 about here

Discussion

Wait time feedback produced a pattern of pausing that facilitated interaction. The greatest change in behavior that was noted in the analysis was the increase in the amount of time that the students were able to actively participate. In contrast to the positive effects of the wait time feedback system, the printed guides were ineffective in changing behavior.

Although the treatment resulted in clearly discriminable patterns of behavior among the groups, many of the teachers were unable to sustain their early gains. Wait times were maintained after the fifth week by fewer than half of those who were successful in reaching the three second pause criterion. In addition, the fact that many of the teachers were unable to reach the criterion at any point in the study when given information about questioning, feedback regarding their pausing, or both certainly reinforces

Rowe's earlier observation that pausing is very difficult to achieve with regularity in the classroom.

Follow-up studies which utilize an improved feedback system featuring more extensive orientation to pausing principles will provide additional information regarding the effectiveness of these procedures as a tool in faculty professional development. It is clear to the authors of this paper that such development is needed in order to improve the quality of classroom discussion.

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Footnote

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Table I

Analysis of Variance Results for Mean Wait Times in Seconds

	Comparison Group	Experimental Groups					
	Group I Mean	Group II Mean	Group III Mean	Group IV Mean		F	P
Wait Time I	1.26	1.34	2.25	1.66	Between Guides	2.324	.129
					Between Feedback	15.672	.00010
					Interaction	4.063	.045
Wait Time II	.55	.67	1.15	.88	Between Guides	.594	.442
					Between Feedback	16.234	.00008
					Interaction	3.725	.055

Appendix

Table 2

Analysis of Variance Results for the Discriminant Function Scores

By Variable 1 (Guides)
Variable 2 (Feedback Device)
Variable 3 (Time)

Source of Variation	Sum of Squares	df	Mean Square	F	Significance of F
Main Effects	109.084	8	13.636	13.566	0.000
Variable 1	2.287	1	2.287	2.275	0.133
Variable 2	66.538	1	66.538	66.197	0.000
Variable 3	40.834	6	6.806	6.771	0.000
Two Way Interactions	56.779	13	4.368	4.345	0.000
Variable 1 Variable 2	1.288	1	1.288	1.282	0.259
Variable 1 Variable 3	12.544	6	2.091	2.080	0.056
Variable 2 Variable 3	43.179	6	7.197	7.160	0.000
Three Way Interactions	15.519	6	2.587	2.573	0.020
Variable 1 Variable 2 Variable 3	15.519	6	2.587	2.573	0.020
Explained	181.382	27	6.718	6.683	0.000
Residual	242.242	241	1.005		
Total (271 Cases)	423.624	268	1.581		

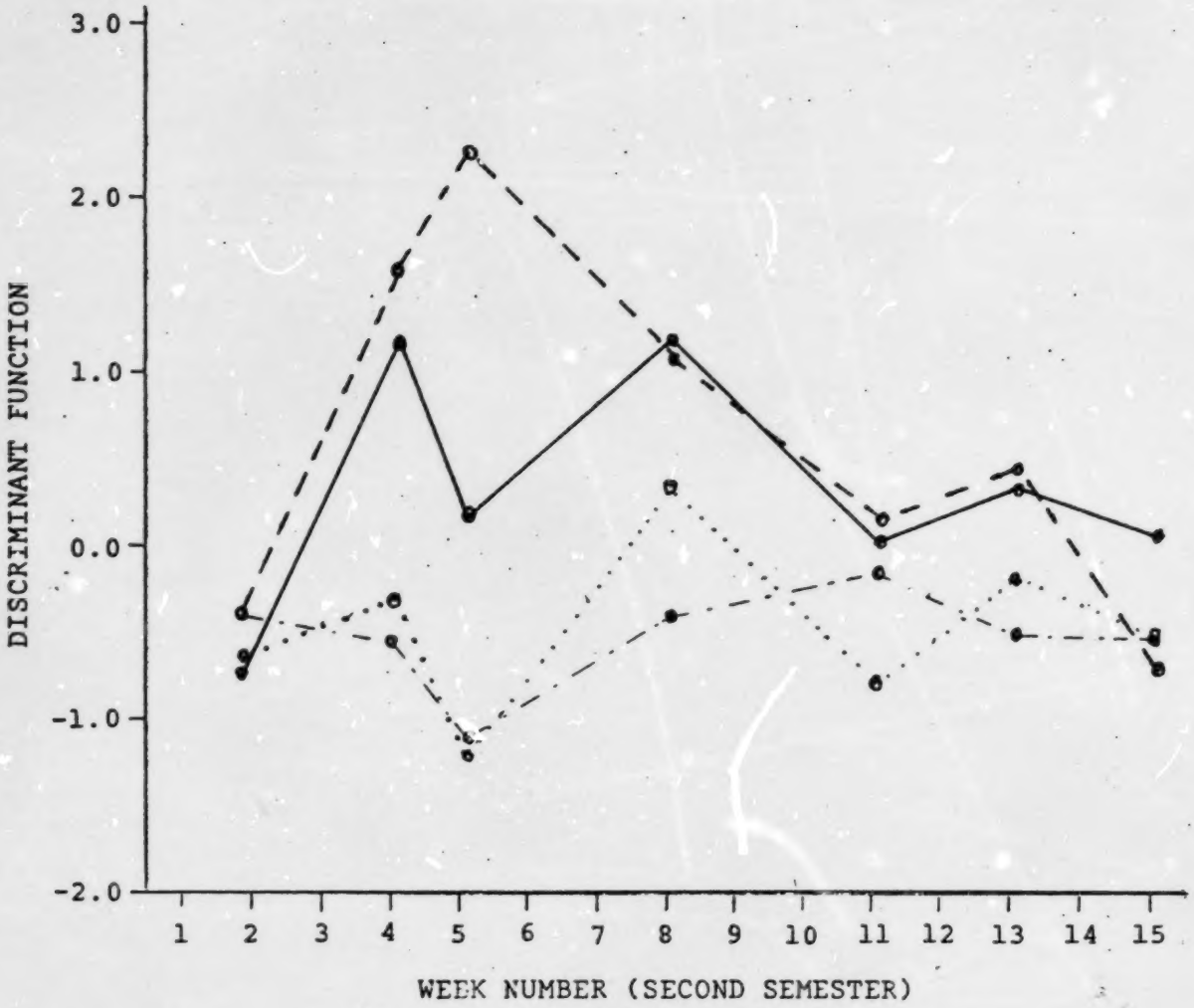
Table 3

Discriminant Function Analysis Cell Means

Week	Groups			
	I	II	III	IV
2	-0.63	-0.41	-0.39	-0.67
4	-0.38	-0.53	1.57	1.18
5	-1.21	-1.13	2.27	0.17
8	0.34	-0.34	1.08	1.19
11	-0.77	-0.16	0.15	0.05
13	-0.17	-0.48	0.45	0.33
15	-0.52	-0.60	-0.73	0.07

		Training: Absent	Training: Present
Feedback: Absent		10 Teachers (Group I)	10 Teachers (Group II)
Feedback: Present		10 Teachers (Group III)	10 Teachers (Group IV)

Fig. 1 Research design



KEY: ------ = Group I (comparison group)

— · — · — = Group II (printed guides only)

— — — = Group III (wait time feedback only)

——— = Group IV (both guides and feedback)

Fig. 2. Canonical discriminant functions evaluated at group means as a function of time in the study.